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SURVEYS AND MAPS - VITAL TO THE SOLUTION OF PROBLEMS OF MASS TRANSPORTATION

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SURVEYS AND MAPS--VITAL TO THE SOLUTION OF PROBLEMS OF MASS TRANSPORTATION

Benjamin Everett Beavin, Sr.*

First let us examine the scope of "Mass Transportation" as it will be used throughout this paper. In addition to railroad and highway, airway and maritime facilities for transporting people and goods en masse, there also must be considered the transportation, by other means, of merchandise, foodstuffs, power, liquids, and gases. By broad definition "Mass Transportation" includes: transportation by canal and pipelines, airways and airports, bridges, tunnels, railroads, highways, harbors, docks, inland waterways, sea routes, transmission lines, and even proposed long distance belt conveyors.

Elevators are the only mass transportation facilities which require very little in the way of surveys and maps.

It is obvious, then, that the mobility of mankind accounts for the vast majority of all engineering projects. If families lived out their lives in a small area which produced all their earthly needs, mass transportation requirements would be insignificant and engineering as we know it would be nonexistent.

As mankind passed from a practically immobile existence to its present state, surveyors and mappers, who originally were a step behind progress, began to struggle to keep abreast of events and their efforts now are so vital to the solution of complex problems of mass transportation that little or no progress can be made unless surveys and maps are available.

It is estimated that a very large part of the costs of engineering design for mass transportation, perhaps as much as one-third, are represented by control and detailed surveys, photogrammetric and other maps, and by that part of the working drawings that is devoted principally to showing planimetry and topography of the area traversed.

If one adds the costs of the tedious construction stakeout and checking surveys, it appears that a very large part of all engineering cost is accounted for by surveying and mapping. While I do not wish to wander away from the theme of the subject, it does seem that many of our engineering organizations and educational institutions are being extremely shortsighted in their present policy of relegating surveying and mapping to the status of a necessary evil.

It is the author's sincere belief that while engineering projects today are several times as large and complex as those prevalent fifteen years ago, many are being based upon surveys and maps that are distinctly inferior to those considered acceptable at that time. This has come to pass in spite of a constant struggle by the profession to improve techniques and is due largely to the mistaken belief that a saving in time (and consequent interest charges) results from short-cut methods of surveying and mapping, and also is due, in part, to the shortage of young engineers sufficiently trained to carry on the work properly.

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Returning to the principal theme of the paper, the author will attempt to show generally the part that surveys and maps play during the various phases of a new transportation project to discuss special maps and to support the conclusion that they are vital to mass transportation.

Conception Phase: This is the period during which a project is born. Full use is made of aeronautical charts, existing agricultural administration, military and other aerial photographs, assessment, cadastral, current, forestry, geological, ground water, hydrologic, land classification, mineral, postal route, railroad, relief, road, topographic and other maps. In addition to the basic planning of proposed improvements, the task of convincing the policy making boards of public and private bodies is very much easier if the proposals are accompanied by adequate maps, particularly where judicious use is made of color in bringing out the salient points. Upon base maps compiled data are shown such as distribution of population, products, existing transportation facilities, political boundaries and any others relating to the need for and economic feasibility of the project under consideration. In sparsely settled or poorly mapped areas, the relationship between bench marks previously established to nearby highways, rivers and railroads may be of great assistance. Records of vanished triangulation stations sometimes assist in determining rates of erosion along the coast. Migrations of rivers sometimes may be determined from old land surveys. This phase is characterized by the use of existing data and by the comparatively small amount of new surveying and mapping usually performed. In addition, much reliance is placed upon field reconnaissance.

During the Conception Phase, the probable feasibility of the project is established. Much depends upon the reliability and accuracy of the existing surveys and maps. The author recalls reading advertisements showing tremendous structures with the statement that they started as a pencil line. This is true only if one considers the starting point to be the first pencil line drawn on the earliest survey or map used during the Conception Phase of the project.

The Conception Phase, although not notable for the new surveys and maps produced, is very important. It is during this phase that the quality of surveying and mapping habitually done in the region has its greatest effect on proposed new work. Good surveys and maps are an important national asset. No country can afford to have its projects stunted or aborted by inadequate maps.

Assuming that the project appears to be financially feasible, the next step is the preparation of preliminary plans and estimates.

Preliminary Planning Phase: During this phase, the project is developed in more detail and new surveys and maps are required. It is possible that the studies, preliminary plans and preliminary estimates will prove that the project is not feasible, however, if the work done during the Conception Phase was based upon reliable data, surveys and maps, abandonment is unlikely.

Search for additional existing information usually is made during the Preliminary Planning Phase. Useful information includes plane coordinate projection tables, diagrams and coordinates of all existing horizontal control, bench marks, pierhead and bulkhead line maps, railroad profiles and plans, detailed plans of highways and airports, airport and city zoning maps and ordinances and public utility maps.

Usually the location of or the route to be traversed by a project is fixed generally during the Conception Phase, making it possible to carry out considerable surveying and mapping during the second or Preliminary Planning Phase. In these days of extremely large projects, the interest cost for a

delay of only one day is considerable. Therefore it is evident that surveys and maps should be advanced as far as possible during this phase, even though partial relocations may cause parts of the work to become unnecessary. It follows, then, that the control surveys or reference framework, both horizontal and vertical, should be of the ultimate required accuracy. Plans and specifications for the control surveys should be prepared as for any other utility and, if possible, the field work and computations and adjustments should be made by separate groups. Time apparently saved by short cuts in the control surveys may be lost several times over during the design and construction phases. The major steps in surveying and mapping during the Preliminary Planning Phase are as follows:

(a) Preparing plans and specifications for horizontal and vertical control. From the publications of the government survey agencies, the ACSM and ASCE much helpful information may be derived.

(b) Preparing standards for note keeping and computations. Cards should be made for all horizontal and vertical control marks and filed for easy reference. Cards filed by coordinates are very readily found. In route survey projects with the long dimension generally east and west, cards should be filed in ascending order of X (easting). In projects aligned generally north and south, an ascending order of Y (northing) is desirable. For projects covering large areas, cards should be filed by quadrangles coinciding with the areas covered by small scale map sheets.

(c) Standardizing map sheets, symbols, abbreviations, title blocks, etc. In the absence of standards previously adopted the Joint Army Navy (JAN&MIL) Standards are simple and effective.

(d) Obtaining all reliable existing survey data, and transferring or pasting it upon individual cards and arranging in the same file with the cards for new stations.

(e) Performing the control surveys in accordance with the priorities shown on the survey plan. Wherever practicable, the control surveys, particularly those of a lower order, may follow the exact alignment of the road, railroad, pipeline, or other structure. Often it is not practicable, because of forests, buildings, rough terrain or bodies of water, to carry the higher order control surveys exactly on the desired alignment. In many cases, the desired alignment will not have been determined. The end result is satisfactory if the control surveys are on or near the alignment of the project.

(f) Much time may be saved, existing maps may be used more fully, aerial mapping may be controlled better and survey stations may be recovered more readily if a plus is recorded and an elevation obtained wherever control surveys cross ditches, streams, culverts, fence and wall lines, hedgerows, roads, railroads, power lines, summits, and enter or leave heavy woods. Azimuths or magnetic bearings along such lines add to the value of the control surveys and are especially helpful for later land acquisition surveys. Magnetic bearings should be recorded on the traverse about a half mile apart.

(g) Picture points obtained during the preliminary surveys are less costly than those obtained by making special trips later. Junctions of fences, walls, center lines of well defined roads, flagpole bases,

railroads, and airport paving furnish well defined picture points. In the U.S., the southerly corners of low buildings make good picture points (and very long lasting secondary coordinate stations). The northerly corners are usually not well defined on photographs because of shadows. Picture points should be tied in whether or not the decision to secure new aerial maps has been made. A very large proportion of our country has been photographed by one agency or another, and the use of these existing photographs may be very helpful, if only to reduce the area to be covered by new surveys and maps.

(h) Aerial maps, if required, should be obtained only after careful study of the area to be covered, scale, contour interval and accuracy desired. All of these factors affect greatly the cost and time of delivery of the maps.

(i) It is very helpful, and costs very little, for the survey parties habitually to make a horizon sweep, before leaving a control station, recording clockwise angles from a known backsight to all visible towers, spires, tanks and other marks which probably are coordinate stations. These observations may save a great deal of time and money in detecting and localizing blunders.

(j) Precise angle observations to distant known points should be made as called for on the survey plan, for the purpose of strengthening azimuths.

(k) Quite often several alternate routes are to be studied. Where these alternates form a comparatively small part of the project, the control surveys should be carried, by methods which will give the ultimate required accuracy, through the most favorable route for the survey. If the alternates comprise most or all of the project, lower order surveys may be carried through and the control perfected after final alignment is selected.

(l) Computing and plotting. Computations, wherever practicable, of coordinates should be on the State Plane Coordinate System. This subject was discussed by the author in considerable detail in a paper presented before the ASCE Surveying and Mapping Division, at the meeting held in Philadelphia in April 1946. Elevations, unless local conditions prevent, should be referred to Mean Sea Level.

(m) Soil borings. Results of soil borings, test wells and test pits should be located by State Coordinates with the several strata referred vertically to Mean Sea Level, in order to become permanent and easily used records.

All of the steps enumerated, and many incidental ones connected with the planning have two purposes, (1) to enable the engineer to select the best location for an improvement, to estimate its cost (and that of competitive locations) and to submit reports and recommendations to the Owner for approval and (2) to furnish the reference framework for succeeding phases.

During or at the end of the Preliminary Planning Phase, the crucial decision usually is made, "to build" or "not to build." It is obvious that this decision cannot be made intelligently unless based upon reports, estimates and recommendations which in turn are derived largely from adequate surveys, maps, profiles and cross sections. Here, as in the Conception Phase, adequate surveys and maps are vital to the solution of problems of mass transportation.

Location and Design Phase: The problems of the various modes of transportation and the design methods are so highly specialized and well known that a discussion of them is beyond the scope of this paper. It is sufficient to say that with adequate control surveys and additional detailed field data secured at the time the final location is established on the ground, the resulting working drawings may be used with confidence. The work of establishing the location on the ground is made more certain, and accurate but brief instructions can be given as to selected location. As many location survey parties may be assigned to work simultaneously on the project as the time factor indicates to be desirable. This feature alone will recapture more time than was lost originally in making first class, workmanlike surveys rather than ones that are barely sufficient.

Construction Phase: During this phase, the benefits of adequate control surveys and maps are extensive. The contractor's work is expedited, fewer construction survey men are required and inspector's problems are simplified. One field change due to poor original surveys may delay the project longer than the time saved originally by inferior survey methods. Contractors are allergic to poorly prepared maps and drawings, know that they may expect delays and consequently bid higher. If an engineer has a reputation for habitually performing careful surveys and preparing adequate drawings, the chances are that the reduced prices bid will more than pay for the difference in first cost between adequate and inferior surveys and maps.

The final part of the Construction Phase usually includes "as-built" surveys, profiles and cross sections, and the revision of maps and drawings. If the control surveys were carefully performed and marked permanently in convenient locations, this work is made easier and its cost is reduced. The preservation of the basic control during construction is difficult and requires the interest and best efforts of all concerned.

The benefits of good surveys and maps extend beyond the Conception, Preliminary Planning, Design, and Construction Phases into the Maintenance and Operation Phase. Property line disputes, front-foot assessments, extension of facilities, recovery of underground utilities, connection of branch lines and many other activities are conducted more economically if the original surveys were of appropriate accuracy and coordinated points thereon have been preserved.

Navigation Charts - The preceding part of this paper has been devoted largely to the steps taken in conceiving and building a transportation facility. There is another field, to which a vast amount of effort is constantly being devoted by all countries, namely the preparation and dissemination of aeronautic and hydrographic charts, including those for radar, Loran and Shoran navigation, which make possible the safe navigation of sea and air routes by carriers of passengers and cargo.

Airport Zoning Maps - Through their delineation of the limits of approaches, above which encroachments are not allowed, airport zoning maps become an essential tool for the administration of airport zoning ordinances. Without protection of their approaches, most airports would face early obsolescense.

Soils Identification from Airphotos - Many railroads, airports, pipelines and highways now in existence were built in economical locations selected by careful study of land forms and soils as divulged by aerial photographic maps. In these days of high construction costs, full exploitation of native materials is essential and may be the deciding factor in determining the feasibility of a project. The art of photo interpretation has advanced rapidly during and since our recent war and will play an increasingly important part in the solution of future mass transportation problems.

Cadastral Maps - In this period of world unrest, expropriation and redistribution of land, settlement of new areas, improvement of underdeveloped lands and remapping of developed lands, it is of the greatest importance to future transportation projects that the cadastral (those showing the location, extent or value of land holdings) surveys and maps be made of appropriate accuracy and coordinated on an official system. The acquisition of rights-of-way may be expedited by the use of such surveys and maps.

Not mentioned in detail but very important are the maps prepared for special study and planning purposes, showing origin and destination data, desired lines, trading areas, population distribution and the many other indices customarily used in conceiving, planning and administering mass transportation projects.

In conclusion, it seems to be a fair statement that surveys and maps are vital to the solution of every phase of mass transportation problems and further that well planned, accurate surveys and maps are more economical in the long run than inferior ones.